Chapter 6

REDUCING PESTICIDE EXPOSURE & ENVIRONMENTAL HAZARDS

Pesticides are designed to poison pests. Unfortunately, many pesticides are also toxic to people, desirable vegetation and/or other aspects of our environment. To reduce the risks associated with the use of pesticides, pesticide use restrictions, limitations and precautions such as those described in Chapter 1 to protect agricultural workers and other restrictions described in this chapter have become necessary.

WOOD PRESERVATIVES LIMITATIONS

A number of health-related concerns have been identified with pesticides used as wood preservatives. As a result, the Environmental Protection Agency has classified the three major wood preservatives (creosote, pentachlorophenol, inorganic arsenicals) as Restricted Use Pesticides. This restriction is based on studies that link creosote, arsenic, and a dioxin contaminant of pentachlorophenol to cancer in humans. In addition, these products have caused gene defects (mutagenicity) in laboratory animals. Continued use of these wood preservatives is currently based on regulations that limit how these materials can be applied, where treated wood can be used, and on new labeling directed at consumers.

APPLICATOR PROTECTION

Special precautions for workers who apply pentachlorophenol require that a closed system be used for powdered, flaked, and prilled formulations. Spray applications of pentachlorophenol must be done in a manner to minimize overspray. Where visible mist occurs, workers are required to wear goggles and protective clothing through which the pesticide cannot penetrate. Pregnant women should avoid exposure to pentachlorophenol.

Workers who treat wood with arsenical wood preservatives are required to wear a respirator if the level of arsenic is unknown or exceeds a level of 10 micrograms/cubic meter of air during an 8 hour day (the Permissible Exposure Limit established by the Occupational Safety and Health Administration). Applications cannot leave visible surface deposits of the preservative on the wood.

USE RESTRICTIONS

Wood treated with creosote and pentachlorophenol can no longer be used indoors or where there may be contamination of feed, food, drinking or irrigation water. In barns, stables, and similar sites, wood that is in contact with the soil can be treated with creosote or pentachlorophenol **if it is covered with a sealer** (at least 1 sealer coat for pentachlorophenol, 2 coats for creosote). Sealants must also be applied if wood is likely to be exposed to body contact. **Logs treated with pentachlorophenol can no longer be used for log homes**.

All uses of inorganic arsenical wood preservatives are Restricted Use except for brush-on treatment for commercial construction purposes (not household construction).

The treated wood industry agreed to develop and distribute Consumer Information Sheets to provide information to consumers about treated wood uses and restrictions. Consumer Information Sheets should be requested when purchasing treated wood products.

LIMITING PESTICIDE RESIDUES IN CROPS

The public is greatly concerned about pesticide residues in crops; however, regulations limit these residues to what studies show to be safe levels.

Preventing excessive residues in harvested crops is essential to keeping these pesticides on the market for use in agriculture. Pesticide residues can be limited by:

- following pre-harvest interval requirements;
- applying a pesticide only to crops listed on the label;
- applying a pesticide only by methods listed on the label;
- applying a pesticide only at the rate specified on the label.

PRE-HARVEST INTERVAL

The **pre-harvest interval** is vital to reducing the hazards of pesticide use. It is the minimum amount of time that must elapse between the last pesticide application and harvest. Pre-harvest intervals are established for all pesticide uses on food and feed crops. Required intervals also exist for many ornamental crops. The length of the pre-harvest interval is determined after studies are done on the degradation of the pesticide under labeled use conditions.

The length of the pre-harvest interval varies with different pesticides. Also, intervals for any individual pesticide may vary on different crops on which it is used. Carbaryl (Sevin) applied to apples requires that 1 day elapse between application and harvest; a 14 day pre-harvest interval exists for carbaryl on head lettuce. **Pre-harvest interval requirements are listed on the pesticide label.** Failure to follow these requirements by harvesting prematurely can allow excessive pesticide residues to appear on the crop.

SITE RESTRICTIONS

Pesticides can be applied to only those crops that are specifically listed on the label. Since pesticides degrade at different rates depending on how the crop is grown, use of a pesticide on a crop may depend on how the crop is produced as well as what is grown. For example, pesticide registrations for greenhouse grown tomatoes differ from field grown tomatoes since they are considered as separate crops. Pesticide uses for ornamental plants grown in greenhouses differ when the plants are moved to interior landscaping.

APPLICATION METHOD

The methods that can be used to apply a pesticide are also specified on the label. Complying with these instructions helps reduce the possibility of excess residues on harvested produce. For example, a pesticide may be applied to the root system of the crop but not to the foliar portion (and vice versa). Aerial application may be allowed but not chemigation. Chemigation is typically allowed for overhead irrigation systems but not trickle irrigation.

APPLICATION RATES

Use of a larger amount of a pesticide than the label specifies is a violation of FIFRA and can also cause harmful residues on a crop. Use only the amount equal to or less than that indicated on the label. With

some pesticides, there are also restrictions on how many times they can be applied during a season and the frequency. Ensuring that excess residues do not occur in harvested crops is a major concern when pesticide labels are written. **It is violation of the law to use a pesticide in a manner that is inconsistent with its labeling**.

MANAGING PESTICIDE DRIFT AND VOLATILITY

Drift control is vital during every pesticide application. Several techniques can be used to reduce the possibility of drift:

- use pesticides that have low volatility;
- use formulations that resist drift and volatility;
- use low pressures during spraying;
- use nozzles which reduce formation of small spray particles;
- use high water volumes during application;
- apply pesticides close to the crop or soil surface;
- avoid applying pesticides when the temperature is high;
- avoid applying pesticides during windy conditions;
- use drift reducing adjuvants.

Certain formulations of pesticides can help reduce drift. For example, low-volatile acid and amine 2,4-D formulations have less potential for volatilization than ester formulations. Dust formulations drift much more readily than most sprays. Granular formulations are relatively less likely to drift.

Droplet size of pesticides during application is extremely important in determining the potential for drift. The ability of particles to drift increases greatly as the particle size decreases (below).

Distance water droplets drift while falling 10 feet in winds of 3 miles per hour.

Droplet diameter (microns)	Particle classification	Drift distance
30	Cloud	500
100	Mist	50
200	Drizzle	16

500	Rain	7
The various spray nozzles and application equipment produce a wide range of droplet sizes. There are several techniques that will reduce the number of the smallest particles while still given effective coverage.		

Application pressures are important in determining the sizes of droplets that are formed. As pressure increases, the number of fine particles also increases. Drift can be reduced by reducing sprayer pressures during application.

Nozzle construction can also affect the number of small particles that are formed during spraying. Nozzle tips that produce larger droplet sizes help reduce drift. For example, larger nozzles can be used at lower pressures to get the same volume (Gallons per acre, or GPA) as smaller nozzles operated at higher pressures. Use of higher GPA applications is an alternate means of achieving adequate crop coverage with minimal pressures.

"Thickening" or "drift control" adjuvants can be added to the spray mixture to reduce drift. These compounds can increase the percentage of larger droplets which are formed but do not completely eliminate small droplets.

The weather conditions during application have a great effect on pesticide drift. Air movements, both horizontal and vertical, cause pesticides to move away from where you are spraying. The higher the wind speed, the larger the amount of pesticide that will be carried away. **Pesticides should never be applied during high wind conditions (greater than 10 mph).** This is particularly important when wind direction is likely to move drifted pesticides onto nearby sensitive crops or other sensitive areas. Drift to sensitive areas often can be avoided by spraying when the air is moving away from these areas.

Drift may also increase when warming air near the soil rises. **Applications should be done at times when air and soil temperatures are most similar, often during early morning and late evening**. At this time, vertical air movements are lowest.

If the air near the soil surface is cooler than the air above, an "inversion" exists. Small spray particles remain suspended in the cool air during temperature inversions, and the particles do not settle readily onto soil or plants. Later the suspended particles move out of the crop area on winds and drift. **Pesticide applications should be avoided during inversions.**

Temperature and humidity can affect pesticide drift. When the temperature is high and humidity low, particles evaporate most rapidly. This evaporation causes droplet sizes to decrease and drift more readily. Volatile pesticides also evaporate more rapidly with high temperatures. Pesticides should be applied when the temperature is cool.

Height and orientation of sprayer nozzles can also affect drift. Distance and time for spray droplets to reach plants or soil is directly related to the height at which a pesticide is released. **Sprays should be released as near the target as will permit adequate coverage.** Sprays should also be directed so droplets are propelled downward to reduce the distance of droplet fall.

Vapor drift of soil-applied pesticides can be reduced by properly sealing the soil after application. This often involves proper soil incorporation of the pesticides during application.

AVOIDING POLLUTION OF GROUND AND SURFACE WATERS

Contamination of ground and surface waters is an imminent hazard of using pesticides in agriculture. This potential must be a major consideration in planning for pest control on crop land and other agricultural areas. Elements that enter into water pollution by pesticides are:

- proximity of the treated area to surface waters;
- proximity of the treated area to drinking water wells or aquifers;
- depth to the water table at the treated site;
- soil conditions that increase the potential for the pesticide to leach into groundwater;
- the hazard of the pesticide as potential contaminant of groundwaters;
- conditions during application that affect pesticide drift into surface waters;
- crop management practices that minimize pesticide leaching;
- precautions during application to avoid leaching or direct groundwater contamination.

The potential for ground and surface water contamination should be evaluated whenever determining the need, method and frequency of pesticide use. Pesticides should only be used when and where necessary and only in amounts adequate to control the pests. When there are alternative pest controls available with less water pollution hazard, they should be considered.

Treatment of fields near rivers, streams, and other surface waters are most likely to result in contamination of surface waters. Treatment of fields where there are high water tables (water tables near the surface), or areas near drinking water wells may result in groundwater contamination. Pesticides should never be applied in a location or in a manner that could contaminate water resources.

In determining whether to use a pesticide or which one to use, the likelihood of leaching should be evaluated. Lighter soils and soils low in organic matter are most commonly associated with leaching of pesticides into groundwater. Soil pH (acidity or alkalinity) may also affect the breakdown and leaching potential of a pesticide. In fields where a high potential for leaching exists, pesticides should be avoided or use limited to chemicals that do not readily leach into groundwater. Some chemicals known to be "leachers" are highly water soluble and are weakly bound to soil particles. At sensitive sites where other conditions favor leaching, these pesticides should not be used.

Proper precautions should be taken during application to reduce potential contamination hazards. Application equipment should always be properly calibrated and maintained. Excessive application rates or spills due to poorly maintained equipment can result in high concentrations of pesticides on crops or land. Pesticides should always be applied in a manner that reduces drift. Application equipment should include safety devices to minimize problems with spills and back-siphoning. This includes the installation of backflow control equipment (check valves or air gaps) on filling pipes and in chemigation systems.

Irrigate in a manner that reduces pesticide movement. High rates of irrigation can increase the amount of pesticide leaching. Excessive irrigation can also cause run-off and erosion. Particular care should be given when irrigating shortly after a pesticide application, since the pesticide is in the highest concentration at this time.

Always follow directions on the pesticide label. Application safety instructions and any restrictions on the pesticide's use are on the label. It is the responsibility of the applicator to read and follow all the instructions. The pesticide label is a legal document, and the content of the label may change as manufacturers and the EPA evaluate uses and hazards. Don't take it for granted that the directions for use on the label of the product you use will remain the same from one purchase date to the next. There are criminal and civil penalties for using pesticides in a manner that conflict with the label instructions.

REDUCING HAZARDS TO WILDLIFE

Destruction of wildlife is an unfortunate offshoot of pesticide use. In some cases, such as DDT, the devastating effects have resulted in cancellation of the pesticide registration (DDT use banned by Presidential Order in 1970). Threats to endangered species have become important considerations in registering pesticides for use. Damage to wildlife from pesticide use can be reduced by:

- avoiding pesticides that are highly toxic to wildlife;
- using pesticide formulations that are less hazardous to wildlife;
- applying pesticides in a manner that minimizes damage to wildlife.

TOXICITY

Pesticides vary widely in their toxicity to wildlife. For example, many organophosphate insecticides are quite toxic to birds and mammals. Fish tend to be more susceptible to synthetic pyrethroid insecticides. Often, several effective pesticides may be available and the less hazardous materials can be selected.

FORMULATIONS

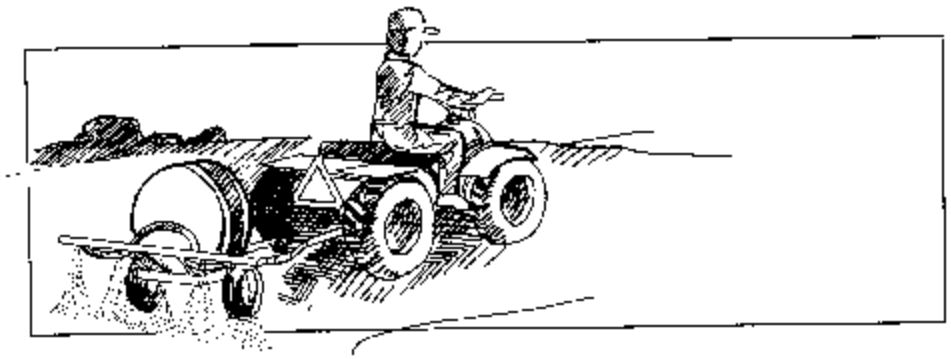
The formulation of a pesticide can make a chemical more or less hazardous to wildlife. Bait formulations for grasshopper control are less harmful to birds than broadcast sprays. Systemic insecticides applied to the soil can be less hazardous to wildlife than sprayed applications. Granules tend to be relatively safe to many types of wildlife; however, granules exposed on the soil surface, particularly colored granules, may be eaten by some animals. Surface exposed granular pesticides and pesticide treated seed have been involved in some serious bird kills. The pesticide, Diazinon, was banned for use on golf courses and sod farms because of its toxicity to birds.

APPLICATION

There are several application practices that can be used to protect wildlife. Pesticides should not be applied to known habitats of desirable wildlife. In some cases, such as prairie dog poisoning, pretreatment surveys for wildlife are required. Also, there are restrictions under the Endangered Species Act on some pesticide uses in areas known to be frequented by threatened or endangered species.

Pesticide applications can be timed to reduce the hazards to wildlife. It may be possible to apply pesticides during periods when migrating wildlife is not present. Delays in treatments may also be considered to allow breeding birds to rear young and disperse from the area.

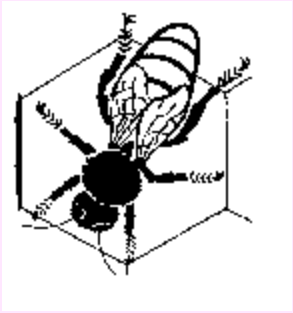
During application, care should be taken to reduce potential exposure of wildlife to pesticides. Pesticides applied to soil or pesticide-treated seed should always be covered with soil. When lifting equipment during field turns, it is possible for granules and seed to spill and pile. Spills or puddling of insecticide spray mixtures can be hazardous since water may attract birds and animals. Steps should also be taken to reduce pesticide drift into areas of wildlife habitat.



REDUCING LOSSES OF HONEYBEES

Honeybees visit fields and orchards to collect pollen, nectar, water and other materials needed to maintain their hives. For many fruit and seed crops, the pollination by bees is essential to crop production. In addition, the honeybee industry and honeybee byproducts provide a major source of income to full and part-time beekeepers, and contributes millions of dollars in value to Colorado agriculture.

Unfortunately, activities of pollinating insects such as honeybees often conflict with crop protection practices. Pesticides, particularly certain insecticides, kill large numbers of honeybees in Colorado annually, destroying or weakening colonies. For example, pesticides used to control alfalfa weevil and sweet corn insects can cause extensive honeybee losses. Steps to avoid these problems include:



- communication and coordination with area beekeepers;
- avoid treatments to crops in bloom;
- control flowering weeds in crops;
- avoid drift;
- use pesticides that are least hazardous to honeybees;
- treat fields during times when honeybees are not active

COMMUNICATION

Regular communication between pesticide applicators and beekeepers is a two-way process that can help protect honeybees. If applicators are aware of the location of bee colonies, they can warn beekeepers of planned applications so that colonies can be moved or temporarily covered. Also, beekeepers can block the main hive entrance and open a new entrance which disrupts honeybee foraging for several hours.

HAZARD

There is a wide range of hazards to honeybees among the various pesticides. In general, relatively slow acting pesticides can be among the more hazardous since they may be carried to the hive and fed to many other bees. Pesticides which are readily collected by foraging bees, such as certain micro-encapsulated insecticides, are also most commonly associated with honeybee poisonings. However, formulation of pesticides can also reduce these hazards. For example, most carbaryl (Sevin) insecticides are considered highly hazardous to bees, but the Sevin XLR formulation is much less hazardous since bees do not easily pick up the insecticide during foraging.

Flowering crops in bloom should not be treated with pesticides that are toxic to honeybees. Indeed, some pesticide labels prohibit the use of the pesticide on crops in bloom. This is often relatively easy when bloom occurs over a limited time, such as with orchard crops; however, the presence of flowering weeds in nearby fields or orchards may attract bees for longer periods. Weed control can therefore be an important factor in reducing honeybee poisoning.

Sometimes crops must be treated when they are blooming because it is critical to crop protection. For example, the sunflower moth lays eggs during bloom and is most easily controlled by applying pesticides at that time. Less hazardous pesticides should be used for these applications. In addition, pesticides can cause less honeybee poisoning if they are applied during periods when honeybees are not active. Early evening is a particularly good time to make these treatments since the spray deposits will have settled and dried before honeybees resume foraging in the morning.

DRIFT

Serious honeybee poisonings can be caused by pesticide drift. During warm periods, large numbers of honeybees may mass on the outside of the hive to help control hive temperatures. These exposed bees can be destroyed easily by drifting pesticides.

(*See also Managing Drift)*

INTEGRATING CHEMICAL AND BIOLOGICAL CONTROLS

Biological controls are important to controlling insects, mites, weeds and diseases of crops. But, they can be eliminated by use of pesticides, causing an even greater dependency on chemicals. Whenever possible, it is wise to integrate chemical and biological controls by practices such as:

- recognition of existing biological controls and evaluating their value before applying any pesticides;
- using pesticides that are less harmful to beneficial organisms;
- timing pesticide applications so they are less harmful to beneficial organisms.

Scouting

Biological control organisms may be effectively controlling pests even though they are not recognized. Even pests that occur regularly, such as spider mites on field corn or greenbugs on sorghum, may be effectively controlled under some conditions. Before applying pesticides, fields should be examined for the activity of natural enemies. If large numbers are present, pesticide use may be deferred or avoided.

Selective Pesticides

When several different pesticides are available, selection of pesticides with less impact on natural enemies can be made. For example, "selective" insecticides (for example, Bacillus thuringiensis for first generation European corn borer or miticides such as Vendex for control of spidermites on fruit trees) can conserve most other biological control organisms.

Insecticides that are relatively short-lived may also be used selectively since resistant stages of the biological controls (eggs, pupae) may survive, allowing fields to be rapidly recolonized. The formulation may also be important in determining selectivity. Formulations of soil-applied systemic insecticides, such as Disyston 15G, can be more selective than the same insecticide used in a sprayed application, such as Disyston 8E.

Timing

Pesticide use may also be timed so the effects on natural enemies will be low. For example, use of dormant sprays on fruit trees before flowering can control pest species on the plant at that time. Biological control organisms typically move to orchards later in the season so would not be affected by dormant applications.

MANAGING PHYTOTOXICITY HAZARDS

Plant damage resulting from a pesticide application to a desirable plant is known as phytotoxicity. Some burn of leaves, flowers, or growing tips will be seen. Yellowing, leaf distortions, abnormal growth and stunting are other signs of phytotoxicity. This is a particular concern where appearance is critical to marketing a crop (tree fruits, flowers, ornamentals).
Phytotoxicity is regularly associated with the use of specific pesticides or formulations on susceptible plants; however, phytotoxicity may be irregular. Problems can be reduced by:

- avoiding use of pesticides on plants known to be susceptible;
- using formulations that have reduced phytotoxcity hazard;
- applying pesticides under the best environmental conditions;
- following label directions on application rates or frequencies;
- avoiding pesticide mixtures;
- never using equipment that has been used for herbicides to apply insecticides or fungicides.

Careful reading of the pesticide label can help identify plants that are sensitive to the pesticide. Warnings may be in the label section that discusses crop uses or in a separate section. They may indicate that only certain varieties are susceptible to injury. Pesticides broadly labeled for use on flowers or ornamentals may not include warning statements for some susceptible plants.

Formulation

Wettable powder and other dry formulations tend to be safer to use on sensitive plants than emulsifiable concentrate liquids. This is because the various "inert" ingredients in some emulsifiable concentrates (xylene, for example) can be harmful to plants. Almost all aerosol formulations of pesticides for use on ornamental plants can cause injury if the spray nozzle is too close to the plant. It should be 18-20 inches or more from the plant.

Weather

Avoid spraying plants during extremely hot sunny conditions. Temperatures above 90 degrees can increase plant injury by many insecticides. During sunny conditions, leaf and flower temperatures may be considerably higher than the air, allowing for injury at lower air temperatures.

Pesticides should not be applied when they will not dry. Plants sprayed when the weather is cool and humid will remain wet for long periods, and there will be increased likelihood of injury. Wet foliage is also more likely to be injured by aerosol formulations. Slow drying is one reason greenhouse grown plants are more sensitive to spray injuries.

Never spray plants that need water. Wilted or dry plants are extremely sensitive to spray injury. Slow growing or diseased plants may also be injured more frequently than vigorously growing plants.

Mixtures/Rates

Excessive rates of pesticides can cause injury. Plants may also be injured by repeated applications made at short intervals.

Certain mixtures of two or more pesticides can cause plant injury. For example, the use of any sulfur based pesticide will cause increased injury if combined with oils. Compatibility charts that can help avoid many mixtures known to cause phytotoxicity are available at most pesticide outlet locations.

Sprayer equipment used for applying herbicides should never be used for spraying insecticides and fungicides. Minute amounts of herbicide residues in such equipment can cause severe damage to desirable plants.

Testing

An important precaution for use of pesticides on flowers and ornamentals is to test the spray mixture on a few plants. Several (3-4) preliminary applications should be made, at short intervals (3-7 days) under normal growing and spraying conditions. Plant damage by some pesticides may appear within 18 hours; with others it may take 3 days. It is useful to compare sprayed plants with adjacent non-sprayed plants receiving identical cultural care.

Summary Chapter 6

Be sure that each person who applies pesticides understands how to use them and follows the label precautions. A supervisor is responsible for everyone under his/her direction.

- Observe Restricted Entry Intervals required by the product label. Never enter a treated field unless trained to do so using required protective equipment.
- The Pre-harvest Interval is the length of time that must pass after a pesticide is applied before harvest of the crop can begin. If not observed, illegal residues may appear on commodities.
- Make sure that pesticides do not drift into areas where other crops, animals, or people will be harmed. Never apply pesticides when there is a wind, or when it is too hot.
- Some pesticides have greater potential for contaminating groundwater than others. Soil, the water table, irrigation practices, and the pesticide's characteristics all contribute to the likelihood of water pollution.
- An undesirable side effect of using pesticides is damage to wildlife and its habitat. Use pesticides in a manner that is least likely to damage wildlife or the environment.

URL: http://www.epa.gov/region08/toxics_poisons/pests/pestmanual/chap6-EXPOSURE.html

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